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(54) Improvements in slurries

(57) Stable coal-water slurries can be prepared from 50-90% by weight coal solids of particle size generally below 0.5mm, water and 0.1-30% by weight of the water of a surfactant of general formula (I)

$$R\text{–}O(\text{–}C_xH_{2x}O\text{–})_n\text{–}H \qquad (I)$$

wherein R is a straight or branched chain alkyl group or an alkylaryl group,
x is an integer from 2 to 6, and
n has a value from 1 to 200

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SPECIFICATION

Improvements in slurries

This invention concerns improvements in slurries, more particularly improvements in coal-water slurries.

Coal-water slurries are the subject of considerable interest in industry as a means for transporting coal by pipeline, as well as for combustion, and certain coal-water slurries are proposed as a liquid boiler fuel for displacing petroleum oil. Research continues, however, in the development of these slurries, not all of which are sufficiently stable for industrial use.

There are two main types of coal-water slurries which have gained acceptance; those for industrial combustion where the coal-water slurry is atomised and which are prepared from a coal feed which is generally ground to less than 300 microns particle size (ie pulverised fuel feed size) and those for certain other applications such as coal transport, Pressurised Fluidised Bed Combustion (PFBC) and blast furnance injection, where coarser coal feeds can be used. This size distribution of these feeds can be continuous, two examples of which are a mono-modal distribution resulting from a single grinding, and the blending of different particle size ranges from several single grindings. Alternatively, these coal feeds can be bi-modal or multi-modal where the size distribution has two or more distinct peaks in the size distribution curve and, according to theory, the smaller size particles pack into the spacing between the larger size particles, giving a stable slurry. In some cases, additives are required to maintain the solids in suspension, and some quite complex systems have been proposed. Additionally, proposals have been made to subject the coal and/or the slurry to thermal or chemical treatment in order to improve the stability of the slurry.

The present invention aims to provide a novel coal-water slurry offering the possibility of cheaper production, good stability and additional uses.

The invention provides a coal-water slurry comprising 50-90% by weight of coal solids having a majority of particles below 0.5mm in size, water and 0.1 to 30% by weight of the water of a surfactant of general formula I,

$$R\text{–}O\text{–}(\text{–}C_xH_{2x}O\text{–})_n\text{–}H \qquad (I)$$

wherein R is a straight or branched chain alkyl group or an alkyl aryl group,
x is an integer from 2 to 6, and
n has a value from 1 to 200.

Preferably, the solids content of the slurry is in the range 55 to 85% by weight, and especially preferred slurries have solids contents of 65 to 75% by weight. The coal may be any low rank to high rank subbituminous or bituminous coal or anthracite; the ash content is not especially critical but the moisture content should be included in the assessment of the water content of the slurry. The actual coal may be selected according to the end user's requirements.

It will be appreciated that the maximum coal particle size is greatly in excess of that normally accepted for coal-water slurries for industrial combustion and the slurry of the invention may contain a minor proportion of particles of larger than 0.5mm size, for example up to 2mm. It is preferred that the coal particles are substantially evenly spread through the size range up to about 0.5mm, or if there are peaks in the size distribution such peaks do not form more than 50% of the total particles.

The invention has particular application to coal particles which are the product of froth flotation processes, although it is not limited to such application. The fine coal recovered by froth flotation is created by many different processes in mining, including cutting the coal, transporting and the the various coal preparation processes, so that there is no characteristic single peak in its size distribution. The size distribution will vary according to the type of coal and its mining and subsequent processing, and accordingly it is not expected to be the same from different coal preparation plants, but this is not critical in the present invention. A particular advantage of froth floated fines in the present invention is that no additional, and hence costly, grinding process is required, but at the same time conventional coal-water slurry technology is not effective to provide a stable suspension with a wide particle size distribution. A further problem with froth floated fines is that chemicals used in coal preparation, for example "frothers" and "collectors", are believed to interfere with the action of known and recommended surfactants for coal-water slurries. It has been observed in the research work leading to the present invention that the slurries using froth floated fines improve in stability with time, perhaps indicating that residual chemicals on the particles are being dislodged or neutralised in some way.

The surfactants useful in the present invention include surfactants available from commercial sources. The surfactants may be synthesised from an alcohol of natural or synthetic origin and an alkalene oxide, and the nature of the reaction is such as to give a mixture of products, having a spread of values of n, so that n will generally be an average. The alkalene radical in the surfactant may be straight chain or branched, and x preferably has a value of 2 to 4. Preferred values of n are from 5 to 30, more preferably 8 to 22. The radical R may contain heteroatoms and/or substituents provided that these do not adversely affect the operation of the surfactant, and may contain up to 30 carbon atoms. The R radical is preferably a primary alkyl group of 8 to 12 carbon atoms or an alkyl-substituted benzene ring. Preferred surfactant

concentrations are 0.5 to 5% by weight of the water present.

The slurries of the present invention may contain additional components, including other agents for stabilising coal slurries. These components may include fine clays, preferably of a particle size of less than 30 microns, additional fine coal, preferably of less than 30 micron particle size, and other surfactants, with the proviso that the stability of the slurry is not adversely affected. Certain of the surfactants may give rise to a degree of foaming which may be considered undesirable, but an addition of a defoamer will generally be found to overcome this.

Slurries according to the invention have been found to have viscosities in the range of 5 to 10 poise, which permit satisfactory pumping properties. The slurries may be prepared by simple mixing of the components, and, provided that mixing is thorough, the test slurries have shown a minimum stability of 24 hours, and in some cases of greater than 7 days without further agitation. If the slurry is stirred, the stability of the coal-water slurry will be maintained for longer periods.

The slurries of the invention find utility in any use to which coal-water slurries may be put, including boiler firing and coal transport, although account may need to be taken of the rather large particle sizes compared to prior slurries. Specialised uses may also be suggested, such as for direct injection of the slurry into blast furnaces or gasifiers, for furnaces eg for drying or calcining, for industrial and domestic fluidised bed boilers (ie both large and small scale fluidised bed applications) operated at ambient or above ambient pressures

The invention will now be described by way of example only.

Example 1

Froth floated fines from the coal washeries at Cynheidre and Wernos Collieries in the National Coal Board's South Wales Area, were analysed for size and moisture content, and the results shown in the table below.

TABLE

Percentage retained on screen		*Cynheidre*	*Wernos*
	+6.7mm	–	–
−6.7	+3.35	–	–
−3.35	+1.7	0.7	–
−1.7	+1.0	9.1	0.9
−1.0	+0.5	28.2	14.9
−0.5	+0.25	26.2	22.1
−0.25	+0.125	15.6	20.8
−0.125	+0.063	7.9	15.4
	−0.063	12.3	26.2
Moisture content %		20.6	22.6

Slurries were prepared using samples from both washeries at 70% and 75% solids content, with added water containing 2% or 3% of a surfactant of the general formula I in which R is a straight chain alkyl group of 9-11carbon atoms(average = 10), x is 2 and n has an average value of 9, by mixing with a glass rod. Stability was tested by observing for supernatent water formation and by a rod penetration test involving the passage of a glass rod into the slurry and detecting the formation of regions of phase separation by the alteration of resistance to the rod, and minimum periods of stability of 24 hours were achieved in all cases.

The viscosity of each slurry was measured at various stirrer speeds using a proprietary Brookfield type viscometer, and was found to lie between 5 and 10 poise.

Example 2

The procedure and tests of Example 1 were repeated for both the Cynheidre and Wernos coal samples, but using a surfactant of general formula I in which R was 4-nonyl-phenyl, x was 2 and n had an average value of 20. Each test slurry demonstrated a stability in excess of 24 hours, and many were unchanged after 7 days.

CLAIMS

1. A coal-water slurry comprising 50–90% by weight of coal solids having a majority of particles below 0.5mm in size, water and 0.1 to 30% by weight of the water of a surfactant of general formula (I),

$$R–O–(–C_xH_{2x}O–)_n–H \qquad (I)$$

wherein R is a straight or branched chain alkyl group or an alkylaryl group,
x is an integer from 2 to 6, and
n has a value from 1 to 200

2. A slurry according to claim 1, wherein the coal solids content is 65 to 75% by weight.

3. A slurry according to claim 1 or 2, wherein the majority of the coal solids have a particle size substantially evenly spread through the size range up to 0.5mm.

4. A slurry according to any one of the preceding claims, wherein in the surfactant of general formula (I), R is a primary alkyl group of 8 to 12 carbon atoms or an alkyl substituted benzene ring, x is an integer from 2 to 4, and n has a value from 8 to 22.

6. A slurry according to any one of the preceding claims, wherein the concentration of the surfactant is 0.5 to 5% by weight of the water.

7. A slurry according to any one of the preceding claims, and having a viscosity in the range 5 to 10 poise.

8. A slurry according to claim 1, substantially as hereinbefore described.

9. The use of a slurry amounting to any one of the preceding claims as a fuel for combustion or gasification.

10. The use of a slurry according to any one of claims 1 to 8 for direct injection into a blast furnace.

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